The Case for Time Travel

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Introduction

What is time travel? Intuitively, the idea is simple enough to have dominated science fiction books, movies and TV throughout the twentieth century. But defining time travel is not simple. According to Paul Davies time travel is travel to other times, just as we travel spatially to other places[1]. No doubt this is right, but spelling out the analogy is not as straightforward as it may at first seem (try defining space travel, then exchanging 'time' for 'place' in the definition.)

However, one way to define time travel is via the notion of a *causal process*. The simplest case of a causal process is the trajectory of a particle through time, where we think of the earlier stages of the particle as the cause of later stages[2]. The same can be said for the history of a person—one's earlier stages are (partly) responsible for one's later stages. A full stomach causes nourishment, earlier perceptions are the cause of later memories, and so on. Time travel is where a causal process connects two times in a special way. Dr Who's body is a causal process, and when the Tardis takes him from 1976 to 1876 that causal process connects two times in a special way. I say 'special way' to distinguish time travel from the normal causal process, such as John's life, a causal process, connecting 1965 and 2005, the dates of his birth and death.

Following David Lewis, we can say that a causal process connects two times in a special way when the 'personal' time defined by the causal process is at odds with 'external' time[3]. As measured by his watch, or digestive processes, Dr Who's trip takes 2 hours, let's say, which is at odds with the external time of minus 100 years. In the case of normal causal processes such as John's life, the personal time and external time coincide, so that is not time travel. So we can say

[1] P. Davies, *About Time: Einstein's Unfinished Revolution* (London: Viking, 1995), p. 234.

[2] P. Dowe, *Physical Causation* (New York: Cambridge University Press, 2000).

[3] D. Lewis, 'The Paradoxes of Time Travel', *Philosophical Papers Volume II* (eds) (New York: Oxford University Press, 1986), 67–68.

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that time travel is where a causal process connects two times in a way that involves a temporal discrepancy[4].

This idea of time travel has long given philosophers difficulties. Most recently, in his paper 'Troubles with Time Travel' William Grey presents a number of objections to time travel, some well known in the philosophical literature, others quite novel[5]. In particular Grey's 'no destinations' and 'double occupation' objections I take to be original, while what I will call the 'times paradox' and the 'possibility restriction argument' are versions of well known objections. I show how each of these can be answered, thereby defending the plausibility of time travel.

The 'no destinations' objection

This objection to time travel runs roughly thus: travel is possible only if the destination exists, and in the case of time travel, no destination exists. Grey sees this argument as decisive on only one of two alternative conceptions of the world in time. The 'Heraclitean' conception is that 'the world is in flux'[6]. I understand this as encompassing the views that 'only the present is real'[7] and that unlike the past, 'the future is genuinely open: there is no determinate future fact'[8]. This is contrasted to the 'Parmenidean' conception, according to which 'truth and reality are stable and eternal'[9], which I understand to encompass the views that 'the past present and future are as real as the present'[10] and that contingent truths are true eternally, i.e. have determinate truth values at all times.

On the Heraclitean view, there can be no time travel, Grey argues. Firstly, there can be no time travel to the future. If there is no determinate future, there simply is nowhere to go. Travel requires the existence of the destination. Secondly, there can be no time travel to the past, because the past is 'fixed and determinate and not subject to change.'[11] Time travellers to the past could, contrary to the

[4] Lewis' notion of a temporal discrepancy, by itself, without the notion a causal process, will not suffice as a definition of time travel because it will count cases of closed timelike curves, discussed below, as time travel even if nothing travels.

[5] W. Grey, 'Troubles with Time Travel', *Philosophy* **74** (1999), 55–70.

[6] Ibid., 56.

[7] Ibid., 56.

[8] Ibid., 57.

[9] Ibid., 56.

[10] Ibid., 56.

[11] Ibid., 57.

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Heraclitean view, effect changes. It assumes the past is 'causally accessible'. So, to take time travel seriously one must adopt the Parmenidean conception.

However, while I will not defend the compatibility of time travel with the Heraclitean conception, I have three responses to Grey's actual argument. Firstly, the no-destinations objection cannot be fatal to future time travel on a Heraclitean view. Secondly, the no-past-destination objection should apply equally to the Parmenidean conception. And thirdly, the objection is in any case based on a confusion between causing and changing past events.

Before we address the argument, we should note that modern science has comprehensively answered this objection to future time travel. According to Einstein's special theory of relativity, as a consequence of 'time-dilation', if one travelled in a fast but otherwise normal space ship on a return trip across the galaxy at speeds close to the speed of light, on return one will find one's self to have travelled into the future. For example, depending on the distance and speed travelled, one might travel for two weeks, and on return find 20 years have passed on earth. This is time travel on any reasonable definition. Further, this effect has been experimentally tested, with atomic clocks circumventing the earth on fast jets[12]. These clocks have travelled into the future, which is as comprehensive a refutation of the no destinations thesis as one could ask for. However, this does not show that time travel is possible on the Heraclitean view, since these results may instead be taken as a refutation of that view.

So, firstly, the objection cannot be fatal to future time travel on a Heraclitean view. Grey does not give an explicit definition of future time travel[13]. No doubt on any adequate definition the everyday experience of travelling to tomorrow simply by waiting for the night to pass would not count as time travel. (On our definition, section 1, this is ruled out because it involves no temporal discrepancy). But it is not clear why the no-destinations objection, if valid, would not rule out the possibility of doing this, on the Heraclitean conception. For on that conception tomorrow is not now real, truths about it not yet true, so how can we 'move' to tomorrow? There is no destination to travel to. Assuming with Grey that the Heraclitean view is a coherent view of time, then since on that view we do move to the future, that it is not yet real should not rule out travelling there. And this seems right. It does not matter that the destination does not exist when we depart on our journey. What matters is whether it is there on arrival. (The final section of the road might well not yet be

[12] *American J. Physics*, **31** (1963), 47; **35** (1967), 89.

[13] In fact his definition explicitly rules it out 'Troubles with Time Travel', op. cit., 55n2.

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constructed when we depart on our spatial journey, but we can complete the journey if it is constructed in time for our arrival.) To sum up, since the Heraclitean view must make sense of our moving to tomorrow, and since on that view truths about tomorrow are not now determinate, then the Heraclitean view should be able to make sense of travelling to some more future time, and in particular the belief that truths concerning that future time are not now determinate cannot mean that one cannot travel there.

Secondly, the no-past-destination objection if valid would apply just as well to the Parmenidean conception of time. The objection is that the past is fixed, in the sense that truths about it are true now, they cannot be changed. But the Parmenidean also holds this much, holding further that the same applies to future truths. So if there is an argument to show that one cannot travel into the past because it is fixed in this sense, then that argument applies not only to the past on a Heraclitean conception, but also to the past and the future on the Parmenidean conception of time. So it is odd that Grey takes the no-destinations objection to apply to the Heraclitean but not to the Parmenidean conception of time.

But, finally, the no-past-destination objection is in any case based on a confusion between causing and changing past events (a distinction that Grey himself draws, in section X) and for this reason does not apply on either conception of time. We need not accept the incoherent notion that we can change past events in order to accept the possibility of time travel to the past. If a man lived through the year 1950, then one cannot go back to that year and kill that man, since this would entail a contradiction: the man survives 1950 and doesn't survive 1950. To change the past from what it actually was to something else[14] is an incoherent notion.

But this does not preclude the time traveller from causing things. If it is true that a man died in 1950, then a time traveller can travel back and kill that man that year. This is not changing the past—there is no 'first 1950' in which the man does not die. But it *is* a case of causation—if anything is a case of causation killing someone is. That we can't change past events does not entail that we can't cause past events. So, that the past is fixed does not rule out travelling there, or having effects there. It only rules out changing what happened.

[14] There are other notions of change according to which it would be possible to effect change in the past. We change an object simply by giving it different characteristics at different times. We also change history when we change things from what they would have been had we not so acted. On both of these senses of 'change' we can change the past.

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This is not to say that there are no arguments to show that time travel is not possible on a Heraclitean conception of time. I simply claim that Grey's no destinations argument does not establish this.

The double occupancy problem

Suppose a time machine is to travel back to the same place at an earlier time, and that it will do so by occupying each intervening temporal location at that place, in reverse order. Then there will be the practical problem that the earlier self of the time machine already occupies those locations. When the time machine begins to travel back in time it will immediately crash into itself![15] The problem can be overcome by supposing that you instantaneously move somewhere else to travel back, but this has the disadvantage of involving a major discontinuity. Grey says that a problem with this is that it leads to a one-many problem of identity, presumably because without spatiotemporal continuity there is nothing to determine that the later stage of the time machine—compared to an exact replica—is in fact the continuation of the same machine. But in any case, it can be shown that even for this particular form of time travel the double occupancy problem can be avoided.

Firstly, we should note that this is only a problem for particular types of time travel. The versions of time travel in view in spacetime structures with closed timelike curves, for example, will not have this difficulty (see next section), nor will those fictional accounts that envisage discrete jumps straight to distant spatiotemporal locations.

However, even for cases where the time machine occupies every intervening temporal location on the journey, the problem can be avoided. Take the case of the Feynman electron, which Grey mentions. In Feynman's notorious interpretation of particle pair creation/annihilation, where for example an electron and its antiparticle the positron collide, and disappear leaving just a certain amount of energy, we take the positron to be the same electron travelling back in time. The annihilation and creation events are interpreted to be reversals in time of the particle.

But this shows us how the double occupancy problem should be avoided. For no-one objected to the Feynman interpretation on the

[15] 'Troubles with Time Travel' op. cit., 56–7. The point was also made briefly in P. Nahin, *Time Machines* (New York: AIP Press, 1993), 14–15, but Grey spells it out in more detail, and in any case appears to have been the first philosopher to have noticed the problem.

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grounds that when the electron turned around it would bang into itself! It's clear that this doesn't happen from the fact that the alternative interpretation is that we have two particles colliding, and disappearing. How does a particle turn around in time without getting in its own way? Answer: same way that two particles collide, i.e., by being in motion. How does a police box turn around in time without getting in its own way? Answer, by being in motion when it turns around. To do this sort of time travel you have to take a run up. So, for a time machine to travel back in time on the method envisaged by Grey, it could be moving across a field, and we should also see its reversed later self moving towards it (perhaps an antimatter time machine, perhaps not), and as the switch is hit the two collide, apparently annihilating both. Thus the time machine avoids colliding with itself.

Grey's comment about the Feynman electron is that it 'is not a smooth and continuous worldline, but at best two distinct particle stages punctuated by violent events.' (p. 62) However, it's not clear either why the envisaged time machine reversal cannot be violent, or for that matter why it *should* be violent just because the Feynman reversal is. Without a specific physical proposal under consideration it's hard to make any comment on these possibilities, and as mentioned above, current serious time travel proposals are of a completely different kind to this one.

The times paradox

One well known objection to time travel[16] (though not a common one these days) is that time travel to the past will always involve the contradiction that two events are separated by more than one distinct temporal interval. For example, a time traveller's departure in 2000 will be separated from her arrival in 1960 by the time of her trip (2 hours, say) and the external time interval, minus 40 years. 'We need some explanation of this chronological discrepancy', says Grey[17].

David Lewis' answer is to draw the distinction between the time traveller's 'personal time' as measured by her watch, memory accumulation or biological aging, and 'external time' as measured by usual means[18]. Grey's response to this is simply to move on to discuss other objections, and in his conclusion he says 'Without further explanation ... it is surely reasonable to suppose that there is only

[16] A. Ayer, *The Problem of Knowledge* (Harmondsworth: Penguin, 1956); D. Williams, 'The Myth of Passage', *Journal of Philosophy,* **48** (1951), 457–72; 'The Paradoxes of Time Travel', op. cit.

[17] 'Troubles with Time Travel' op. cit., p. 58.

[18] 'The Paradoxes of Time Travel', op. cit., 146; 'Troubles with Time Travel', op. cit., 63

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one time series, that of physical time, and that this also is the time of our experience.'[19]

However, there is another answer to the times paradox objection —chronological discrepancies are countenanced under the special and general theories of relativity, and in fact are demonstrated by experiment. In particular, as mentioned above, one could take a very fast return trip into space, lasting by your clock 2 weeks, and return to earth to find everyone has aged by 20 years. This time travel into the future involves a chronological discrepancy, and hence leads to a contradiction, according to the reasoning of the times paradox. But since this has been proved by experiment, the time paradox reasoning must somehow be fallacious.

In response to this, Grey claims that 'the chronological discrepancies which arise in connection with the special and general theories of relativity ... are benign in a way that time travel discrepancies are not.'[20] The reason given is that they do not allow the traveller to return before he left. This is true, in that, given that our speeds are restricted by the speed of light, the above method cannot take you into the past. However, this case is all we need to demonstrate that the times paradox reasoning is fallacious, since it supplies contradictory time intervals between two events. There is just as much a contradiction in this case—between two hours and 20 years—as there is in cases of backwards time travel.

But, in any case, there are other types of temporal discrepancies countenanced in modern physics, of which Grey seems curiously unaware. Any spacetime involving closed timelike curves allows time travel into the past. Gödel[21] was the first to show that there are solutions to GTR in which spacetime contains closed timelike curves, and more recently many other possibilities for closed timelike curves have been investigated[22]. Perhaps the easiest to envisage

[19] Ibid., 69.

[20] Ibid., 58.

[21] K. Gödel, 1949, 'An Example of a New Type of Cosmological Solution to Einstein's Field Equations of Gravitation'. *Reviews of Modern Physics,* **21**, pp. 447–50; K. Gödel, 1949, 'A Remark About the Relationship Between Relativity Theory and Idealistic Philosophy', in *Albert Einstein: Philosopher-Scientist*, (La Salle: Open Court, 1949) Schlipp, P. (ed.), pp. 557–62.

[22] R. Kerr, 'Gravitational Field of a Spinning Mass as an Example of Agebraically Special Metrics', *Physical Review Letters,* **11** (1963), 237; F. Tipler, 'Rotating Cylinders and the Possibility of Global Causality Violation', *Physical Review D,* **9** (1974), 2203; K. Thorne, *Black Holes and Time Warps* (New York: Norton, 1994); J. Gott, 'Closed Timelike Curves Produced by Pairs of Moving Cosmic Strings: Exact Solutions', *Physical Review Letters* **66** (1991), 1126.

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is the wormhole which connects two spacetime points such that by entering the later mouth and travelling (forwards in time, locally) down the wormhole, one emerges from the earlier mouth. In such spacetimes we do indeed have exactly the kinds of temporal discrepancies that Grey asserts 'are not sanctioned by the alternative metrics of physics'[23].

The possibility restriction objection

Grey's main 'trouble' with time travel is that it involves 'reverse causation' (where a later event causes an earlier event), which entails restrictions on the sorts of thing that are possible, e.g. for a time traveller to do. These restrictions are so unbelievable that we should reject time travel as a very implausible hypothesis. As Grey puts it, 'Although [reverse causation] may not be self-contradictory it does lead to intolerable restrictions on the range of possibility, and the range of efficacious choice available to an agent.'[24]

Grey gives the following example. A button sends a signal into the past by one hour, where it causes the detonation of an explosion in the same room. If the button is located close enough to the explosives, then clearly it cannot be pushed since if it were it would have been blown up. But it's hard to see what would stop someone from pushing that button. 'The facts of the story do not however square with the belief that we *can* choose efficaciously.'[25] Something that seems perfectly possible for a person to do is in fact impossible, incredibly.

That example focuses on the capacities of an agent. A second example concerns physical possibility. Suppose time traveller Dum travels back in time and mates with Jocasta, producing a child who is in fact himself, Dum. In that case it is 'impossible for [Dum] and Jocasta to have produced a daughter, ... and that is simply incredible.'[26] Presumably what is incredible is that their having a daughter is impossible even though by the normal laws of reproduction it has a chance of about 50%. Again, what seems perfectly possible is in fact impossible, incredibly.

As Grey is aware, David Lewis has provided a detailed reply to this objection[27]. According to Lewis the time traveller has normal

[23] 'Troubles with Time Travel', op. cit., p. 69.
[24] Ibid., 70.
[25] Ibid., 66.
[26] Ibid., 68.
[27] 'The Paradoxes of Time Travel', op. cit., 77–8.

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capacities (although there are strange things associated with time travel), as follows. We take as true those 'can' statements which are 'compossible' with certain facts—which facts being given implicitly by the context of the statement. In Lewis' example time travelling Tim can shoot his grandfather since 'he has what it takes'—a good gun, full intention, the right opportunity and perfect conditions. Shooting his grandfather is compossible with those facts—exactly all the kinds of facts that we normally take to be relevant to whether one person can shoot another. So Tim can choose efficaciously if anyone can.

Grey disagrees with this conclusion.[28] As Lewis points out, there is also a sense in which Tim cannot kill his grandfather in 1922, since it is not compossible with the broader delineation of facts which includes the fact that his grandfather dies in 1957. Lewis allows both senses of 'can', as an equivocation, on the grounds that the truth of 'can' statements is context dependent. Grey apparently rejects Lewis' account of the context dependence of can statements, saying 'the general rule is to hold the background as fixed as possible', and therefore infers that there is no sense in which Tim can kill his grandfather.

However, if this is Grey's position, he needs to show why he is not implicated in a further argument put by Lewis. According to Lewis to say that since it is true that Grandfather will die in 1957 Tim cannot kill him in 1922 is a piece of 'fatalist trickery', slipping in facts that we normally do not take as relevant in deciding whether someone can do something, facts disguised as if they were relevant.[29] This means on the 'Parmenidean' account of time, which Grey is granting for the sake of argument, and according to which contingent truths are true timelessly, that given Grey's approach to can statements we cannot *ever* choose efficaciously, we only think we can. Tim cannot kill his grandfather in 1922 because it is not compossible with his 1957 death, but by the same fatalist reasoning no-one can kill a person at times prior to that person's death. This would mean that, granting Grey's approach to can statements, it is simply false that time travel entails restrictions that are simply incredible. Rather, it merely entails restrictions that are true for us in any case, without time travel. A more plausible option might be to accept Lewis' account of the context dependence of can statements, thereby allowing that choices we normally take to be efficacious really are, and therefore also that in that same sense time trav-

[28] He is not the first to do so, see K. Vihvelin, 'What Time Travellers Cannot Do', *Philosophical Studies,* **81** (1996), 315–30.

[29] 'The Paradoxes of Time Travel', op. cit., 78–9

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ellers also choose efficaciously.[30] But either way, there is no case against time travel.

Conclusion

I have presented a case for time travel by showing how to overcome four difficulties presented recently by William Grey. First, according to the 'no-destinations' objection, on the Heraclitean conception of time there is no future destination to travel to because the future doesn't exist, and there can be no past destination to travel to because to do so would suppose that the past can be changed, but the past is fixed. If valid this would be disastrous for the Heraclitean conception because it would equally apply to the way we 'go to' tomorrow simply by waiting. Fortunately for the Heraclitean conception the objection is not valid, because travel to a destination seems merely to require that the destination exists at the time of arrival.

The 'no past destination' objection (which applies as much to the 'Parmenidean' conception) is based on a confusion between changing past events and causing them. That it is incoherent to suppose one could change a past event does not entail that one could not cause that past event.

Second, the 'double-occupancy' objection is the worry that when you hit the reverse button your time machine will crash into its past self. The solution to this problem is simply to ensure that you are moving when you hit the button. In any case, the worry does not apply to the more serious time travel proposals under debate in contemporary physics, which don't involve such 'turn-around' events.

Third, Grey asks for an explanation for the time discrepancies that inevitably arise in time travel; indeed, that are built into our very definition of time travel. However, whatever need there may be for an explanation, this cannot be an objection to the plausibility of time travel because experiments have shown the time travel into the future actually occurs. It follows that temporal discrepancies, having been observed, are clearly possible.

Finally, according to the 'possibility restriction' objection, a time traveller will find herself restricted in the things she can do to an extent that is 'incredible'. But Lewis' answer to this objection seems sufficient. According to Lewis we 'can' do what is compossible with a set of facts as implicitly fixed by the context. On this account, the time traveller can do the same things we think we can do: time

[30] See B. Brown, 'Defending Backwards Causation', *Canadian Journal of Philosophy* **22** (1992), 429–44.

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travel implies no special restrictions. Alternatively, rejecting Lewis' context dependency account such that it turns out that the time traveller cannot do such things seems also to entail that we can't do things we normally take ourselves to be able to do. If that is so, then the restrictions implied by time travel are not incredible.

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